

# The Effect of Teacher Training Programs on Pre-service Mathematics Teachers' Beliefs towards Mathematics<sup>\*</sup>

Yüksel DEDE<sup>a</sup>  
Gazi University

Fatih KARAKUŞ<sup>b</sup>  
Afyon Kocatepe University

## Abstract

The aim of this study was to determine the effects of teacher training programs on pre-service mathematics teachers' beliefs about mathematics. The sample of the study consisted of 173 pre-service mathematics teachers from an education faculty in the Central Anatolia Region of Turkey. The data were obtained from an open-ended questionnaire, categorized in terms of content analysis and analyzed quantitatively. The results of the study showed that there was no statistical difference between both elementary and secondary pre-service mathematics teachers' beliefs from when they started the teaching program to when they graduated from the programs. Yet, the mean scores about mathematical beliefs in the senior class were higher than those of the freshman class.

## Key Words

Beliefs towards Mathematics, Change in Beliefs, Effect of Training Program, Pre-service Mathematics Teacher, Teacher Training Program.

Mathematics education reforms in the world also have affected the Turkish mathematics education system, moving from traditional approaches to content-based approaches based on problem solving (Baki, 2008). In accordance with the 2005 teaching program reforms in Turkey, a constructivist approach was adapted. Teachers' roles changed from traditional to guidance within the curriculum (Milli Eğitim Bakanlığı, 2005). Conducting a successful curriculum mostly depends on the teachers (Çakıroğlu & Çakıroğlu, 2003). In many researches it was found that teachers and pre-service teachers attended these re-

forms, but they did not reflect the approaches focused on in these reforms into their teaching (e.g. Gooya, 2007; Gregoire, 1999; Hiebert & Stigler, 2000; Toluk-Uçar & Demirsoy, 2010). However, it is frequently mentioned in the literature that teachers' beliefs and teachers' perspectives effect their behavior and attitude during their teaching period (e.g. Hacıömeroğlu, 2011; Kayan & Çakıroğlu, 2008; Pajares, 1992; Raymond, 1997; Thompson, 1984; Toluk-Uçar & Demirsoy, 2010; Toluk-Uçar, Pişkin, Akkaş, & Taşçı, 2010;). In this context, it is very important to examine the change in teachers' and pre-service teachers' beliefs.

<sup>\*</sup> A part of this study was presented as an oral presentation at the X. Ulusal Fen ve Matematik Eğitimi Kongresi in Nigde (June 27-30, 2012).

<sup>a</sup> Yüksel DEDE, Ph.D., is currently a professor of mathematics education. His research interests include mathematics education, affective behaviors in mathematics education (especially teaching and learning values) and teacher education. *Correspondence:* Gazi University, Gazi Faculty of Education, Department of Mathematics Education, 06500, Teknikokullar, Ankara, Turkey. Email: ydede2000@gmail.com

<sup>b</sup> Fatih KARAKUŞ, Ph.D., is an assistant professor of mathematics education. Contact: Afyon Kocatepe University, Faculty of Education, Department of Mathematics Education, 03200, Afyonkarahisar, Turkey. Email: fkarakus@aku.edu.tr

In the literature it is stated that there is not any agreement on the definition of beliefs (Ernest, 1989; Pajares, 1992; Thompson, 1992). Schoenfeld (1985) and Sigel (1985) focused on the fact that belief occurs relative to one's experiences thus focusing on its cognitive dimension. Furinghetti and Pehkonen (2002) and Richardson (2003) focused on the affective dimension of belief. Ernest (1989) defines belief towards mathematics as an individual's comprehension values, ideology and tendency towards mathematics. He classified belief towards mathematics as instrumental, Platonist and problem solving. Dionne (1984), on the other hand, classified belief towards mathematics as traditional, formalist and constructivist. Törner and Grigutsch (1994) stated that mathematical belief has three components: toolbox, system and process. These different views are more or less related to each other (Liljedahl, 2009). Ernest emphasized mathematics teachers' beliefs in three subcontexts: beliefs about the nature of mathematics, beliefs about the teaching of mathematics and beliefs about the learning of mathematics. Beliefs about the nature of mathematics deal with what mathematics is used for and what its qualifications are. Beliefs about the teaching of mathematics deal with how teaching is expected to be done and which materials and methods are going to be used during teaching. Beliefs about the learning of mathematics deal with the beliefs of teachers on how they conceive of the learning of mathematics and which activities are appropriate for them (Baydar & Bulut, 2002; Ernest, 1989). Feiman-Nemser, McDiarmid, Melnick, and Parker's (1988) studies were in accordance with Ernest's study towards describing this classification. Philippou and Christou (1999) and Steinbring (1998) stated that teachers' beliefs effect their teaching period as well as their classroom activities. Teachers' beliefs towards mathematics can be formed in two ways: a) the studies examining the relationship between teachers' beliefs and their teaching practices regarding mathematics (e.g. Beswick, 2006; Hart, 2002; Raymond, 1997; Thompson, 1984) and b) the studies defining teachers' beliefs about the nature of mathematics, the teaching of mathematics and the learning of mathematics (e.g. Adnan & Zakaria, 2010; Paksu, 2008; Shahvarani & Savizi, 2007). Since most of our beliefs are resistant to change, being formed in childhood and during the experiences of school life (Frank, 1988), studies examining the change in teachers' beliefs show that teachers are extremely resistant towards changing their current beliefs (Hiebert & Stigler, 2000). It is clear that the studies about the effects of teacher education programs on pre-service teachers' beliefs

show two different results. The first is that they have little impact on teachers' beliefs (e.g. Lortie, 1975; Prawat, 1992; Raymond, 1997; Weinstein, 1989). The other is that teacher education programs have an impact on pre-service teachers' beliefs (Hart, 2002; Wilkins & Brand, 2004). In Turkey, when studies about teachers' and pre-service teachers' beliefs about mathematics were examined, they generally focused on beliefs about self-efficacy (Dede, 2008; Doruk & Kaplan, 2012) and problem solving (Hacıömeroğlu, 2011; Kaya & Çakıroğlu, 2008). However, in recent years, there are a few studies focusing on pre-service teachers' beliefs and anxieties regarding mathematics (e.g. Hacıömeroğlu, 2013), beliefs about mathematics and teaching practices (e.g. Toluk-Uçar & Demirsoy, 2010), and beliefs about the nature, teaching and learning of mathematics (e.g. Kaya, Haser, & Bostan Işıksal, 2013).

### Purpose

The purpose of this study was to determine the effects of the teacher education program on elementary and secondary school pre-service teachers' beliefs about the nature, teaching and learning of mathematics.

### Method

The descriptive method was used in this study. In descriptive studies, a given situation is carefully described as completely as possible (Büyükoztürk, Çakmak, Kılıç, Özcan, Karadeniz, & Demirel, 2011). The purpose of such research is to define what an event is and describe its components in order to interpret, compare, classify and analyze (Cohen, Manion, & Morrison, 2007).

### Sample

The sample under investigation was comprised of 173 pre-service teachers from a university in the Anatolian region of Turkey. 91 pre-service teachers were from the department of elementary mathematics education and the other 82 were from the department of secondary mathematics education in the same education faculty.

### Data Collection Instrument

Data was collected from the six open-ended questions prepared within the interview questions used in the Banks (2005) and Bütün (2005) studies about

teacher and pre-service teachers' beliefs regarding mathematics. Among the open-ended questions, two questions, "If your friends ask you what is mathematics, what would you answer?" and "What is the source of mathematical knowledge?" were about the nature of mathematics. Two other questions, "What do you think is the best way to learn mathematics?" and "what do you do when you encounter difficulty in learning a mathematical concept or topic?" were about the learning of mathematics. The last two questions, "What is the most effective way to learn mathematics?" and "What do you do when faced with teaching a mathematical topic that you don't exactly understand?" were about the teaching of mathematics.

### Data Analysis

There are some studies which use quantitative analysis methods while analyzing qualitative data (e.g. Abeyasekera, 2005; Bernard, 1996; Winch & More, 1956; Young, 1981). In this study qualitative data was analyzed by using the quantitative method. In this context, content analysis was used to analyze the data. The main aim of content analysis is to show concepts and relationships that can explain the collected data (Miles & Huberman, 1994; Tavşancıl & Aslan, 2001). Firstly, research helps determine the general categories and sub-categories. In this study, three general categories were identified: traditional beliefs, transmission beliefs and non-traditional beliefs, according to the Ernest (1989), Raymond (1997) and Toluk-Uçar and Demirsoy's (2010) studies. After examining the beliefs based on these three different categories, statistics was used to determine the effect of the teacher education program on the pre-service teachers' beliefs. One point for those with traditional beliefs, two points for those with transmission beliefs, and three points for those with non-traditional beliefs were assessed. Finally, if the score for one pre-service teacher's beliefs about mathematics came near to nine, he/she was considered to have non-traditional beliefs. In this way, qualitative data was converted to quantitative data, and using Tekin's (1996) study this data was scored. To determine if there was a significant effect from the teacher education program on the pre-service teachers' beliefs about mathematics, descriptive statistics and a t-test were used. Moreover, eta-squared values were calculated in order to examine the effect of any meaningful difference between groups (Cohen, 1988).

### Reliability of Study

In this study a theoretical triangulation was done (Cohen et al., 2000) according to the categories prepared using the Ernest (1989), Raymond (1997), and Toluk-Uçar and Demirsoy's (2010) studies. Pre-service teachers' views were evaluated under these categories. In this stage, no change was made to the words used by the pre-service teachers and the written text was shown to them for their approval. Hence, reliability of the data was acquired (Creswell, 1998). Additionally, a peer review was used in order to confirm the data as reliable (Lincoln & Guba, 1985).

### Results and Discussions

Both elementary and secondary school pre-service teachers had traditional beliefs about mathematics when they began the teacher education program. Parallel to this research, Kagan (1992), Haser (2006) and Demirsoy (2008) indicated that pre-service teachers began the teacher education program with traditional beliefs. Moreover, both elementary and secondary school pre-service teachers held their traditional beliefs about mathematics when they graduated from the program. However, Kayan et al. (2013) found that primary pre-service mathematics teachers had more constructivist beliefs about mathematics. This shows that the teacher education program had different effects on pre-service teachers' beliefs. Yet, senior class pre-service teachers in both programs had higher beliefs on average than the freshman pre-service teachers from both programs. Thus, the teacher education programs effected the pre-service teachers' beliefs, but they were not enough for changing them. Vacc and Bright (1999), Wilkins and Brand (2004), Işıkoğlu (2008), and Haser and Doğan (2012) stated that some courses such as subject area teaching methods, and one's experience in the teacher education program had an effect on changing pre-service teachers' beliefs. Both elementary and secondary school pre-service teachers had traditional beliefs about the learning of mathematics when they began the teacher education program. When they graduated, however, the elementary school pre-service teachers had transmission belief scores about the learning of mathematics, but secondary school pre-service teachers held their traditional belief scores. That is, elementary school pre-service teachers' belief scores were higher than secondary school pre-service teachers' belief scores in regard to the learning of mathematics. The reasons for this could be the teaching methods as well as the secondary school teachers'

education program having more theoretical courses than the primary school education program.

The results of the pre-service teachers' beliefs about the nature, teaching and learning of mathematics are as follows:

a) Both elementary and secondary school pre-service teachers had traditional beliefs about the nature of mathematics when they began the teacher education program. But, secondary school pre-service teachers had higher belief scores. When they graduated, both elementary and secondary school pre-service teachers also had traditional beliefs about the nature of mathematics.

b) Both elementary and secondary school pre-service teachers had traditional beliefs about the teaching of mathematics when they began the teacher education program. Although beliefs leaned towards transmission beliefs, both elementary and secondary school pre-service teachers had traditional beliefs about the teaching of mathematics when they graduated.

c) Both elementary and secondary school pre-service teachers had traditional beliefs about the learning of mathematics when they began the teacher education program. When they graduated, the elementary school pre-service teachers had transmission beliefs scores about the learning of mathematics, but secondary school pre-service teachers had traditional beliefs scores. That is, elementary school pre-service teachers' beliefs scores are higher than secondary school pre-service teachers' beliefs scores about the learning of mathematics.

The results of the pre-service teachers' beliefs about mathematics in terms of grade levels are follows:

a) In terms of grade levels, there was no statistical difference between freshman pre-service elementary school mathematics teachers and senior pre-service elementary school mathematics teachers' beliefs about the nature of mathematics, but there were differences between them according to their beliefs about mathematics, the teaching of mathematics, and the learning of mathematics.

b) In terms of grade levels, there was no statistical difference between freshman pre-service secondary school mathematics teachers and senior pre-service secondary school mathematics teachers' beliefs about the nature of mathematics, but there were differences between them according to their beliefs about mathematics, the teaching of mathematics, and the learning of mathematics.

c) In terms of the teacher education program there was no statistical difference between freshman elementary school and freshman secondary school pre-service mathematics teachers' beliefs about mathematics, the nature of mathematics, and the teaching and learning of mathematics. When they graduated, there was no statistical difference between senior elementary and senior secondary school pre-service mathematics teachers' beliefs about mathematics, the nature of mathematics, and the teaching of mathematics. Yet, it was determined that there was a significant difference between them regarding their beliefs about learning mathematics in favor of the elementary school pre-service teachers.

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